Quorum Communication, Inc.
3807 Carbon Road
Irving, Texas 75038-3415 USA

August 11, 2016

Ms. Marlene Dortch,
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

RE: Reply Comments in Response to RM-11681 Petition for Rulemaking: Ligado's Request to Allocate the 1675-1680 MHz Band for Terrestrial Mobile Use Shared with Federal Use

Dear Ms. Dortch:

Background

Quorum Communications is a small business that provides radio frequency components for satellite earth stations, demodulators, and complete end-to-end earth stations for meteorological and environmental applications. Our subsystems are a part of nearly every vendor's meteorological satellite-receiving systems that are sold in the Americas, Asia and Europe. We have supplied components that provide the key radio frequency reception capability for systems which include these companies:

Lockheed Martin
Global Science and Technology
Harris Corporation
Microcom Design
Marta Systems
Seaspace
SSEC Madison Wisc.
EEC Weathertech
Visalia
Global Imaging

These vendors provide receiving systems for both the GOES Data Collection System and the direct broadcast downlink from GOES-NOP. Most of these vendors plan on offering products to receive DCS or direct broadcast from the new GOES-R series satellites, which are either within 1675-1680 MHz or directly adjacent to that band segment for services within the current allocation of 1675-1695 MHz. This list represents nearly all the major vendors of hydro-meteorological receiving systems from the GOES / GOES-R satellites in this hemisphere, who supply both Federal and non-Federal users.

We currently provide the radio frequency subsystems in the GOES-R Rebroadcast receiving systems supplied to the National Weather Service.

We also provide the antenna radio frequency electronics as a supplier to Lockheed Martin for the USAF Mark-IV-B Meteorological Data Station (AN/UMQ-13). To quote the Lockheed submission in this proceeding, "[T]he system, known as Mark IV-B, includes image processing and analysis software and restricted image product sharing capabilities across all USAF sites. Today, multiple USAF Mark IV-B systems are in the process of being upgraded for receipt of the future, much larger GRB stream from GOES- R/S/T/U. … The GRB stream, like the GVAR downlink today, will provide real-time weather image data at the lowest latency possible for operational use by meteorologists. In a forecast setting, the immediate availability of such images is critical to making short-fused decisions about weather warnings[1]."

Further Background: Current Interference Issues to Federal and non-Federal Receiving Systems for GOES NOP – GVAR and Design Modifications

Quorum Communications is currently assisting in the redesign of the current Mark IV-B antenna feed electronics to reduce the adjacent band interference present today on GVAR[2] receiving systems that originate from terrestrial signals in either 1670-1675 MHz or above 1710 MHz, and to mitigate the future impacts from AWS-3 transmissions in 1695-1710 MHz.

Before the addition of the proposed Ligado tower transmitters into the lower end of this band, which would clearly create additional interference into a receiving system, our users and in testing of our own systems, we and many of our customers already see large levels of interfering signals that have required three separate upgrades to the filtering and components in our GOES-NOP GVAR receiving products over the last 10 years.

These design changes include incorporating larger cavity filters, increasing the dynamic range of the mixers and IF amplifiers and additional post downconversion IF filters. Quorum Communications has enhanced the design several times for antennas used to receive geostationary weather satellites (e.g. GOES) to protect users of the GVAR downlink from disruptive interference. Mainly this has involved increasing the selectivity of the filters used before the first low noise amplifier as this is the best place to try to eliminate the interference before it enters the signal chain. Filters are not perfect devices and as they become more complex to try to attain the desired "brick wall" between the desired signal

[1] Comment by Lockheed Martin, FCC proceeding RM-11681, dated June 21, 2016

[2] GVAR is the direct broadcast downlink on the current GOES-NOP series of satellites that downlinks the science data and imagery from the operational GOES satellites to data users.

and the interference they start to introduces problems which reduce the sensitivity of the earth station and also introduce distortion to the desired signals. In most of our upgrades we could improve these filters and solve the problem but now we have reached the point where the interfering signals are too close to filter off so part of the adjacent signal will enter into the receive chain of electronics. Once these signals get into the receiver downconversion chain they start overloading the electronics since they are so much stronger than a weak signal from a satellite 22,000 miles away.

For the filter redesigns we have completed, each cavity filter has grown in size and weight as additional sections are added to improve the interference rejection. In order to attempt to preserve the system sensitivity the filters become more exotic and grow in size and must be machined, usually from blocks of aluminum which then must be silver plated and then assembled. The current filter design in support of the GOES-R GRB downlink, to protect it as much as we can from out of band emissions, weighs between 3 and 4 pounds each and are large and expensive.

The cavity filters shown below in the illustration show the relative growth in size of filters as we have redesigned to increase the mitigation due to adjacent band interference. This interference originates from terrestrial transmitters in either 1670-1675 MHz or above 1710 MHz as seen by receiver electronics operating in 1675-1695 MHz. The Visible Infrared Spin Scan Radiometer (VISSR) was first carried on the first series of geosynchronous weather satellites, SMS-1 launched in 1974. Early satellites in the GOES series also carried a VISSR instrument and sported a VISSR downlink[3]. Each newer version of filter is larger in size, creates additional signal loss to the desired satellite signal, and is heavier and more costly to procure.

[3] GOES Project History, https://www.nasa.gov/content/goes-overview/index.html as accessed on August 10, 2016

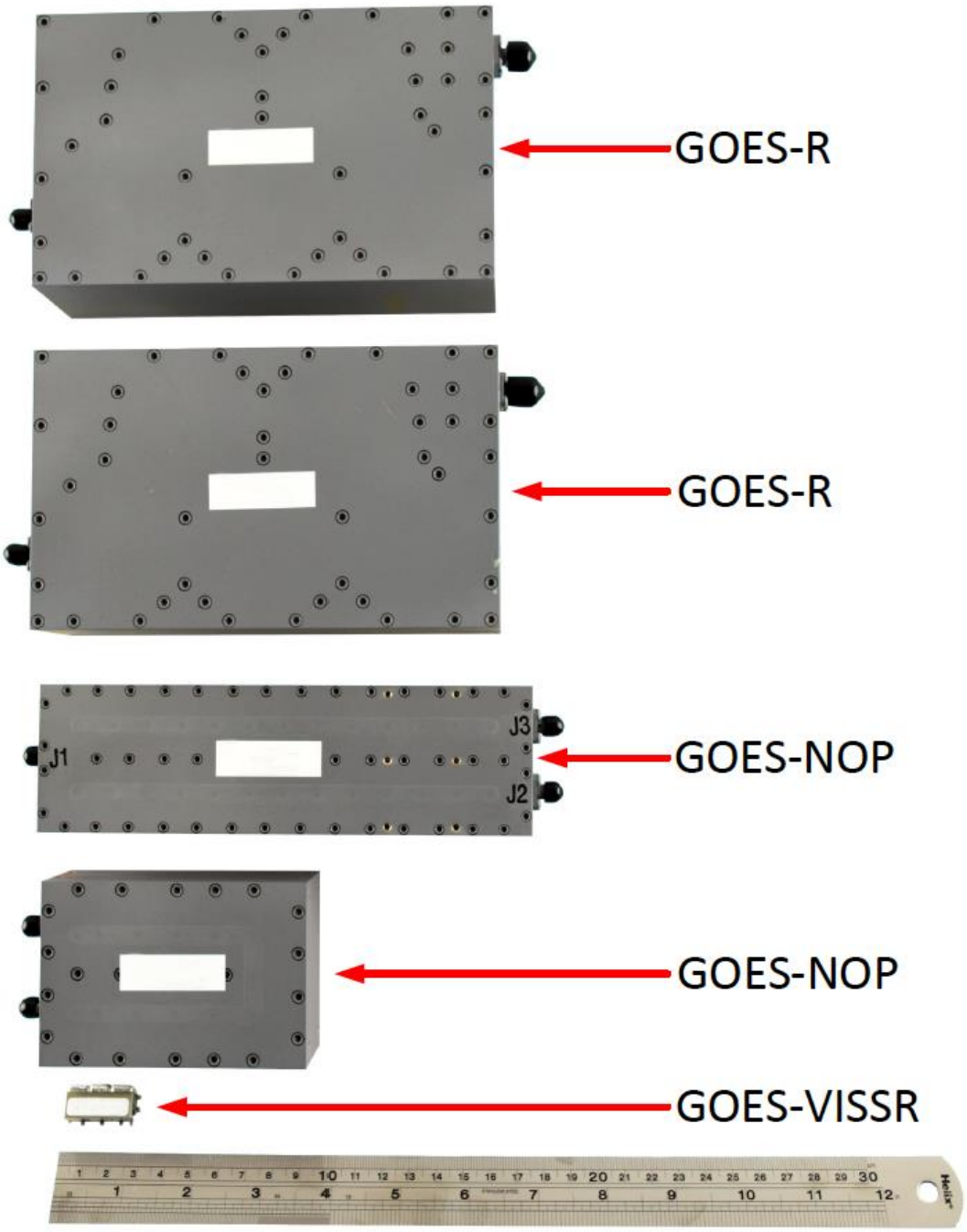
GOES-R
GOES-R
J3
J1
J2
GOES-NOP
GOES-NOP
GOES-VISSR

Illustration of the Relative Sizes of Filters Used to Mitigate Radio Frequency Interference in the 1675-1695 MHz Band

Impact of Ligado sharing proposal on receiving systems in 1675 to 1680 MHz abd 1675-1695 MHz

In the opinion of our engineering staff, we feel that we are now reaching the practical limit of what we can do to avoid interference. With the proposal by Ligado, to share 1675-1680 MHz, it would not be possible to incorporate a filter to reduce this signal versus the receipt of in-band signals such as the GOES-R DCS system. Adding a filter to reduce the unwanted signal would also reduce the overall performance of the earth station due to losses in the filter. And when one considers the difference in signal levels between the 32 dBW signal proposed by Ligado and the relatively weak downlink signals from the satellite, it is akin to what one company stated "it's like comparing a flashlight with the illumination from the sun"[4].

If the FCC adopts this proposal to share 1675-1680 MHz, no practical filter changes would be available to mitigate the effects of such a strong signal, as both the interfering signal and the desired satellite downlink signal are just simply too close together.

Operating such strong terrestrial transmitters, whose signals would be stronger than the desired satellite downlink signal, at significant distances from the satellite ground station location, would most certainly have impact on the ability for a hydro-meteorological user to receive the GOES-R satellite downlink, with few or no mitigations available to insure reliable reception under all conditions.

After reviewing the comments of receiving system manufacturer Microcom Design[5], we would agree that the GOES-R receiving systems needed to operate with the GOES DCS system are endangered. We would agree with the statement "Having extensive experience in RF communications in general, and satellite communications specifically, Microcom is well aware of the potential for a terrestrially generated signal to interfere with a satellite downlink, but due to adjacent signals, be even more so, in-band signals."

---

[4] We would also like to note that although the AWS-3 auction in 1695-1710 MHz has concluded and licenses have been awarded, none of those licensees have begun to operate broadband user equipment in 1695-1710 MHz as of this date. Those future signals could also contribute to the interference environment which may be seen by satellite receiving systems, for which these filters would be used to help mitigate any adjacent band interference effects.

[5] Letter from Microcom Design, Inc., FCC proceeding RM-11681, dated June 17, 2016

Excessive power levels from adjacent signals that enter the passband of a sensitive satellite earth station can cause compression of the amplifiers, pushing them to operate in non-linear regions of the design, and causing a failure of the system to successfully capture the desired signal.

We agree with the observation that receiving systems in the northern latitudes, such as Canada, with rather low antenna elevation angles pointed south, directly toward the United States, would likely be susceptible from interference caused by terrestrial systems that are located many miles away, originating from proposed terrestrial towers in 1675-1680 MHz[6].

Conclusion

Quorum Communications is opposed to the sharing of the 1675-1680 MHz band and does not recommend that the Federal Communications Systems move forward with any further action in this matter. We believe the introduction of transmitters in the 1675-1680 MHz band would create significant issues for GOES / GOES-R direct broadcast end users. Many users have invested in satellite earth stations to reliably receive DCS or GOES direct broadcast signals from geostationary orbit. Many have either already purchased or expressed interest in purchasing stations for the upcoming GOES-R series that will launch in November 2016. They feel the investment to procure and operate such a receiving system is necessary to meet their operational requirements.

Thank you for considering the reply comments of Quorum Communications.

Sincerely,

Richard Fogle

Quorum Communications, Inc.

[6] Comment of the Government of Canada, FCC proceeding RM-11681, dated June 21, 2016